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VARIATION OF *POLYGYRA ALBOLABRIS* IN MICHIGAN.

BY BRYANT WALKER.

Polygyra albolabris Say is not only the largest, but one of the most abundant and widely distributed species of the genus. It inhabits the whole of the Eastern States and Canada, ranging north to the Saskatchewan, south to Florida and west to Nebraska, Kansas and Texas. It may be fairly said to be the characteristic land snail of the region.

In view of the enormous extent of territory which it occupies, and the very diverse environmental conditions to which it is subjected, it would naturally be expected to show a very considerable range of variation. This is true particularly in the Southern States, where in the southeast two well-marked varieties (*major* Binn. and *fuscolabris* Pils.) have been developed, and in the southwest a third (*alleni* Weth.), which practically replaces the typical form west of the Mississippi from Missouri to Texas.

In the region north of the valley of the Tennessee River and east of the Mississippi, however, the typical form is everywhere present and, except in size and contour, presents no substantial variation.

Barring var. *dentata* Tryon, a dentate form, and var. *fusca* Billings, a color variation, which do not come within the province of this paper, the only varieties to receive recognition have been based mainly on size. There have been three of these to appear in the literature, of which only one has been fully described, viz.: var. *maritima* Pils.¹ from the New Jersey coast. Var. *minor* Sterki² from New Philadelphia, O., is simply stated to be "a peculiar, small, thin-shelled form." While var. *traversensis* Leach³ was never described at all, but was a MSS. name attached to a small form collected by Leach near Traverse City, Michigan, which is stated by Pilsbry⁴ to be "scarcely distinguishable" from var. *maritima*.

In the preparation of the writer's *Illustrated Catalogue of the Mollusca*

¹ *Proc. Acad. Nat. Sci. Phila.*, 1890, p. 283.

² *L. and F. W. Mollusks of New Philadelphia, O.* (1894). The var. *minor* of Wetherby (1881) and of Sampson (1893) are referred to var. *alleni* Weth. by Pilsbry, *Proc. Acad. Nat. Sci. Phila.*, 1903, p. 197.

³ *Manual of Conch.*, IX, p. 76 (1894).

⁴ *Cat. Land Shells of Am.* (1898).

of Michigan, the fact of these references to a small form of *Polygyra albolabris* raised a question as to whether there was really a small race in Michigan worthy of varietal distinction or not, and led to the investigation, the results of which are embodied in this paper.

The material used consisted of 511 specimens, contained in six distinct sets as follows:

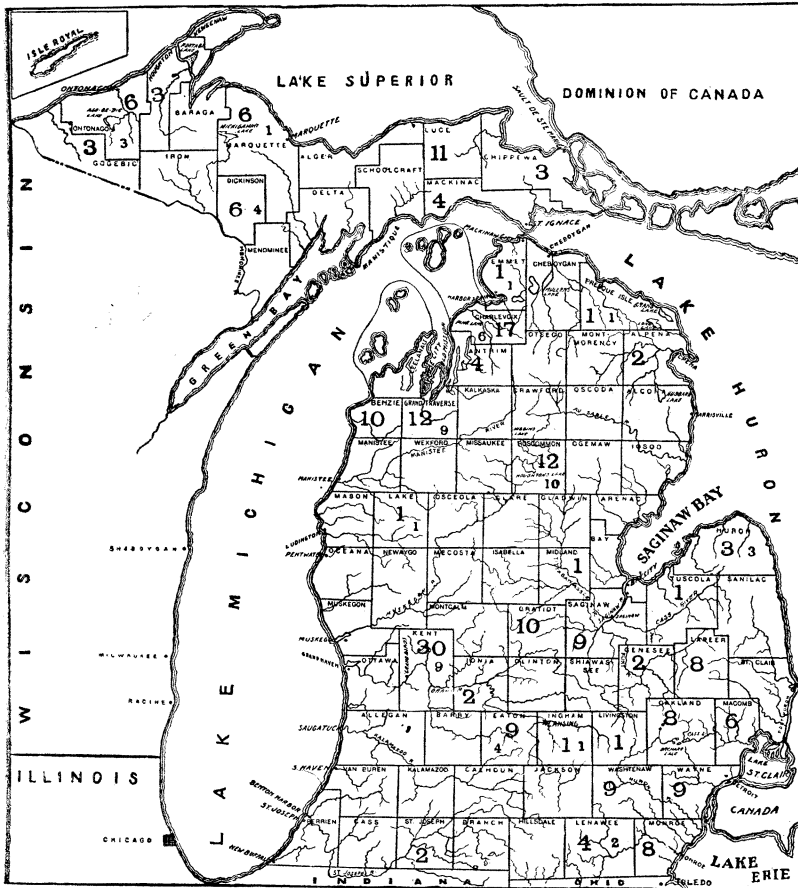


Fig. 1.

I. Two hundred and twenty-five specimens, representing the writer's collection of Michigan *albolabris*. These shells are from all parts of the State. It contains 53 separate lots, varying from 1 to 11 in number, from 38 of the 83 counties of the State. The accompanying chart

shows the various counties represented in the collection, and the larger figures the total number of specimens from each county. While an inspection of this chart shows a lamentably large number of counties wholly unrepresented, it is to be borne in mind that the physical conditions of Michigan are much more uniform than in many other States where there is a greater diversity of surface, and that, therefore, as far as they go the specimens from the region south of the Saginaw-Grand Valley may be fairly considered as representative of all the counties in that district; the shells from the Grand Traverse region as of those characteristic of the sandy plains of the northern part of the Lower Peninsula, and those from the Upper Peninsula as representative of that region.

The small number of specimens from so large an area is, of course, unfortunate, but that could not be helped.

In considering the results of a study of this series, it is necessary to bear in mind the manner in which it has been accumulated. It is not an entirely "unprejudiced" series of specimens, *i.e.*, it does not include in every instance *all* the specimens that were collected at the locality represented. The collection in this particular may be divided into three classes:

1. A very considerable number of sets, mostly small in number of individuals, which are all the specimens that were collected at the particular place represented.
2. Sets received from correspondents, which were, no doubt, selected from a more or less extensive series of duplicates.
3. Sets collected by myself and selected from a larger number of specimens. In such cases it has always been my intention to preserve a representative series, consisting of the extreme forms and a fair representation of what appeared at the time to be average specimens. But, of course, the proportion of extreme specimens would be largely in excess of what it would be had the whole series been retained.

In view, therefore, of the very large proportion of selected specimens included in the series, it would seem likely that the series as a whole would give results, especially as to size, that would be in excess of that obtained from an entirely unprejudiced series.

II. One hundred and twenty-four specimens from Isle Royale, Lake Superior, Mich., collected by the University of Michigan Expedition in 1906. This series includes all the specimens collected on the island. The number of specimens was so much larger than the series from any other Michigan locality that it was deemed best not to incorporate it with the general Michigan series, on account of the

preponderating influence it would have in determining the extent of variation in the shell as a whole. As shown by figs. 5 and 7, however the results, so far as the variation in height and width are concerned would not have been substantially changed. But the size of the average shell would be considerably reduced.

III. One hundred and fifty-two specimens from Cincinnati, O., collected by the late A. G. Wetherby. This was Prof. Wetherby's duplicate series, and may be fairly considered to be a representative series from that locality. It was used as being the only large series from a single locality available as a basis of comparison with the Michigan specimens.

IV. Seven specimens of *P. albolabris maritima* Pils. from Cape May, N. J., viz.: 3 from the collection of Mr. G. H. Clapp; 3 from that of the writer and the type as given by Pilsbry in the original description.

V. Three specimens of *P. albolabris minor* Sterki from New Philadelphia, O., received from Dr. Sterki.

VI. Nine specimens of the original lot of *P. albolabris traversensis*, collected by Leach near Traverse City, Mich. This set is also included in the general Michigan series (I).

For the purpose of comparing these different series and platting the results, three different measurements have been used:

1. The height, which is the distance from the apex to the lower base of the lip, measured on a line parallel with the axis.

2. The greater diameter, measured on a line at right angles to the axis and including the lip.

3. The ratio of the height to the diameter, obtained by dividing the altitude by the width, the resulting percentage being the axial index of the shell.⁵ This method in the case of *albolabris* gives a reasonable basis of comparison as to the proportionate height of the shell, although it is obvious that it is neither accurate nor satisfactory as a basis for a comparison of shape, as two shells may have the same axial index and yet one be trochiform and the other planorboid. Owing to the comparatively low spire and large body whorl of *albolabris*, no satisfactory method of determining the comparative elevation of the spire and angular divergence of its sides has been suggested, and attempts in that direction were abandoned as futile.

⁵ See Baker, *Am. Nat.*, XXXVIII, p. 661 (1904).

THE CINCINNATI SERIES.

Say did not give the locality of his type of *albolabris* nor its height. Its width is given as one inch. W. G. Binney (*Manual Am. Land Shells*, p. 299) gives 30 x 17 mm. as the size of typical *albolabris*, but gives no information as to the basis on which the measurement was determined.

In the absence of any better basis for comparison, the Cincinnati series was adopted as probably representative of the species in the Ohio Valley and a locality about midway between the northern and southern range of the typical form.

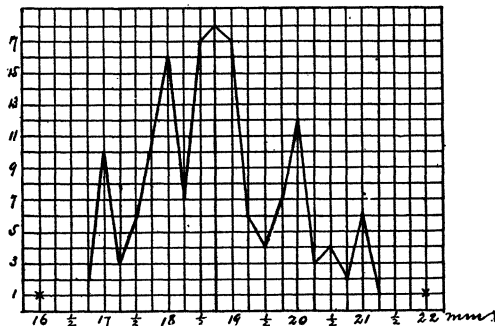


Fig. 2—Heights—152 Cincinnati.

The Cincinnati shells exhibit considerable variation in height, but within comparatively narrow limits, ranging from 16 to 22 mm., the average being 18.78. The major mode is at 18.75, with minor modes at 17, 18, 20 and 21. It is to be noted that practically one-half (75) of the specimens are from 18 to 19 mm. in height.

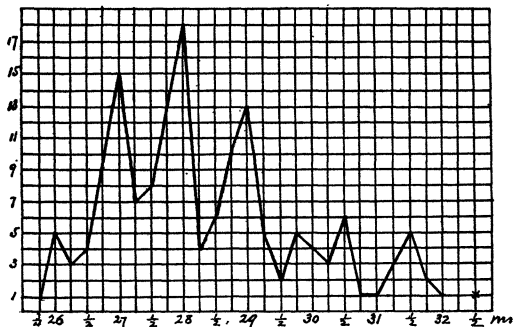


Fig. 3—Widths—152 Cincinnati.

The variation in width is within rather larger limits, ranging from 25.75 to 32.5 mm., with an average of 28.35. The curve is practically trimodal, the major mode being at 28 and the minors at 27 and 29. Ninety-four specimens or nearly 62 per cent. are from 27 to 29 mm. in diameter. It is also to be noted that only a single example is less than 26 mm. in diameter.

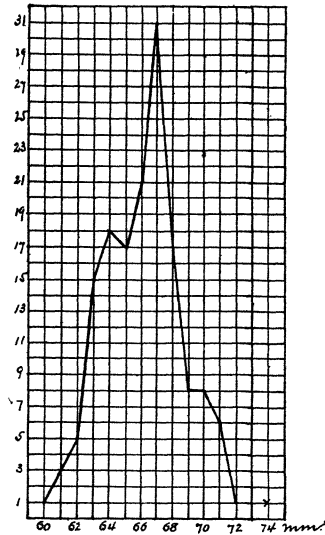


Fig. 4—Axial index—152 Cincinnati.

In comparison with the variability in height and width, the curve of the axial index is remarkably simple, showing great uniformity in the series in the general proportions of the shell. The curve is practically unimodal, culminating at 67 per cent., the average being 66 per cent. Eighty-nine specimens or 58 per cent. have an index between 66 and 68 per cent.

THE MINOR VARIETIES.

The number of authentic specimens of the three smaller varieties available for study is too small to justify platting a curve for them separately.

The dimensions of the several specimens of each form are as follows:

1. Var. *maritima* Pils.:

| | | | | | | | |
|------------|--------------------|-------|-------|-------|-------|-------|-------|
| Alt..... | 13.00 ^o | 17.50 | 15.25 | 15.25 | 16.00 | 17.00 | 15.00 |
| Diam..... | 22.00 | 24.00 | 23.00 | 22.00 | 22.50 | 24.00 | 21.50 |
| Index..... | .59 | .73 | .66 | .69 | .71 | .71 | .70 |

^o Pilsbry's type.

The average shell is 22.7 x 15.6 mm., with an index of .68. Compared with the remainder of the series, the type is more depressed, having an index of .59 as against an average index of .70.

2. Var. *minor* Sterki:

| | | | |
|------------|-------|-------|-------|
| Alt..... | 15.75 | 13.75 | 13.25 |
| Diam..... | 24.00 | 20.50 | 19.25 |
| Index..... | .66 | .67 | .69 |

The average shell is 21.25 x 14.25 mm. with an index of .67.

3. Var. *traversensis* Leach:

| | | | | | |
|------------|-------|-------|-------|-------|-------|
| Alt..... | 14.00 | 13.50 | 13.75 | 13.00 | 12.25 |
| Diam..... | 23.75 | 21.25 | 20.50 | 21.00 | 19.75 |
| Index..... | .59 | .61 | .67 | .62 | .67 |

| | | | | |
|------------|-------|-------|-------|-------|
| Alt..... | 15.00 | 13.75 | 12.50 | 12.00 |
| Diam..... | 23.00 | 22.00 | 20.50 | 20.00 |
| Index..... | .65 | .63 | .61 | .60 |

The average shell is 21.31 x 13.31 mm. with an index of .63. At the same time that Dr. Leach collected these recent shells, he also collected a series of fossil shells from the marl lying beneath the present forest, where the typical set was found. The series is of interest as showing that, as a local form, this variety has existed in the same place for a very long period of time and substantially unchanged in character. The dimensions of this series (14) are as follows:

| | | | | | |
|------------|-------|-------|-------|-------|-------|
| Alt..... | 15.00 | 17.75 | 17.00 | 15.75 | 16.50 |
| Diam..... | 23.00 | 25.75 | 26.00 | 23.25 | 23.00 |
| Index..... | .65 | .67 | .65 | .68 | .72 |

| | | | | | |
|------------|-------|-------|-------|-------|-------|
| Alt..... | 16.00 | 14.50 | 14.50 | 13.00 | 14.00 |
| Diam..... | 25.00 | 22.00 | 22.25 | 21.25 | 21.50 |
| Index..... | .64 | .66 | .65 | .61 | .65 |

| | | | | |
|------------|-------|-------|-------|-------|
| Alt..... | 14.75 | 12.00 | 12.75 | 12.50 |
| Diam..... | 22.50 | 18.00 | 19.00 | 17.50 |
| Index..... | .66 | .66 | .67 | .71 |

The average shell is 22.14 x 14.71 mm. with an index of .66. Comparing this series with the recent shells, it is to be noted that while the range of variation both in height and width is greater in the fossil series, the average shell in each series is very nearly the same. The

fossil shell, however, is slightly larger, .83 mm. in diameter and 1.4 mm. in height, and proportionately higher.

Comparing the average shell of the four series, we have:

| | Alt. | Diam. | Index. |
|-----------------------------------|-------|-------|--------|
| <i>maritima</i> | 15.60 | 22.70 | .68 |
| <i>minor</i> | 14.25 | 21.25 | .67 |
| <i>traversensis</i> (recent)..... | 13.31 | 21.31 | .63 |
| “ (fossil)..... | 14.71 | 22.14 | .66 |

This shows that, while all the western shells are smaller and more depressed than the eastern form, the average *minor* and fossil *traversensis*, though somewhat smaller than the average *maritima*, have nearly the same index. The recent *traversensis*, however, are not only considerably smaller but also proportionately more depressed. While the recent shells are too few in number and too variable to establish a satisfactory curve, the following arrangement of the several frequencies in the 19 specimens is nevertheless of interest, both as showing the range of variation and for comparison with other series.

| | | | | | | |
|-----------|-------|-------|-------|-------|-------|-------|
| Diam..... | 19.25 | 19.75 | 20.00 | 20.50 | 21.00 | 21.25 |
| No..... | 1 | 1 | 1 | 3 | 1 | 1 |

| | | | | | | |
|-----------|-------|-------|-------|-------|-------|-------|
| Diam..... | 21.50 | 22.00 | 22.50 | 23.00 | 23.75 | 24.00 |
| No..... | 1 | 3 | 1 | 2 | 1 | 3 |

Average, 22.97 mm.

| | | | | | |
|----------|-------|-------|-------|-------|-------|
| Alt..... | 12.00 | 12.25 | 12.50 | 13.00 | 13.25 |
| No..... | 1 | 1 | 1 | 2 | 1 |

| | | | | | |
|----------|-------|-------|-------|-------|-------|
| Alt..... | 13.50 | 13.75 | 14.00 | 15.00 | 15.25 |
| No..... | 1 | 3 | 1 | 2 | 2 |

| | | | | |
|----------|-------|-------|-------|-------|
| Alt..... | 15.75 | 16.00 | 17.00 | 17.25 |
| No..... | 1 | 1 | 1 | 1 |

Average, 14.21 mm.

| | | | | | | |
|------------|-----|-----|-----|-----|-----|-----|
| Index..... | .59 | .60 | .61 | .62 | .63 | .65 |
| No..... | 2 | 1 | 2 | 1 | 1 | 1 |

| | | | | | | |
|------------|-----|-----|-----|-----|-----|-----|
| Index..... | .66 | .67 | .69 | .70 | .71 | .73 |
| No..... | 2 | 3 | 2 | 1 | 2 | 1 |

Average, .66.

Comparing these results with those derived from the Cincinnati series, it is to be noted:

1. That while both series vary greatly in diameter they do not overlap, there being a break of 1.75 mm. between the largest of the "minor" series and the smallest of the Cincinnati shells. The average diameter of the minor series is 22.97, as against 28.35 mm. in the Cincinnati series, and that while 62 per cent. of the Cincinnati series are from 27 to 29 mm. in diameter, more than 68 per cent. of the minor series are from 20 to 23 mm. in width.

2. That notwithstanding this great difference in size, the proportions of the shells of both series are substantially the same, the index of the minor series ranging from .59 to .73 and that of the Cincinnati series from .60 to .74, the average index in both series, however, being the same, .66.

3. That while perhaps it may be claimed that the minor series is too small, in proportion to the Cincinnati series, to give any satisfactory comparison, nevertheless the evidence, such as it is, certainly tends to show the existence of a smaller race of substantially the same general shape, but averaging 5.36 mm., or 19 per cent., smaller in diameter.

THE GENERAL MICHIGAN SERIES.

As shown by the figure, this series exhibits great variability in

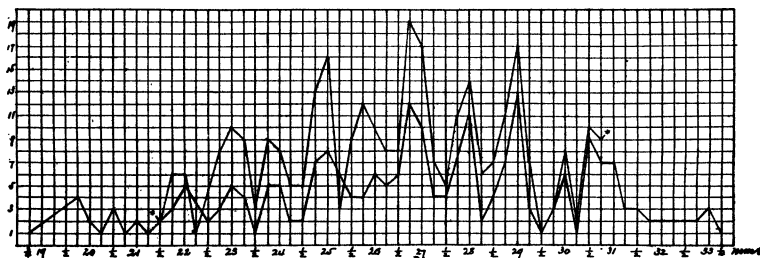


Fig. 5—Widths—Upper line, 225 Michigan and 124 Isle Royale. Lower line, 225 Michigan.

size, ranging from 18.75 to 34.25 mm. in width, with an average of 26.95. The major mode is at 29, with minor modes at 30.5, 28, 26.75 and 25. The average is 26.95 mm. There is a decided break at 24.5, below which there is a series of minor modes at 24.23, 22 and 19.75.

Were it not for the strong minor mode at 24.75 and 25, the break at 24.5 would be much more conspicuous. As the fifteen specimens

aggregated at these points are from twelve different localities, scattered all over the State and in both peninsulas, it is evident that this is a feature of the Michigan race as a whole, and not the result of a few sets of strongly characterized local forms. The same peculiarity appears in the Isle Royale series (fig. 12), and is intensified when the two series are combined (fig. 5). It is similar to the strong minor mode culminating at 30.25. Indeed, the diversion of the whole series between 24.50 and 34.25 mm. into five well-marked groups is quite striking. In the same way the minor series below 24.5 is divided into five similar groups.

It is to be noticed that the break in this series at 24.5 is substantially at the same place where the break occurs between the *Cincinnati* and the "minor" series. This is apparently more than a mere coincidence. It is certainly corroborative evidence tending to strengthen the inference drawn from the comparison of those series.

Of the 225 specimens in the Michigan series, 55 are 24.5 mm. in diameter or less and 170 are more than 24.5. Of the smaller group 8 are from the Upper Peninsula and 47 from the Lower. Of the larger series 34 are from the Upper and 136 from the Lower Peninsula. That is, in the Upper Peninsula 19 per cent. belong to the smaller race and 26 per cent. in the Lower Peninsula.

In fig. 1 the number of specimens of 24.5 mm. or less in diameter from each county are represented by the smaller figure. Thus in Kent County, of the 30 specimens in the series, 9 are of the smaller race.

In considering the probability of the existence of a small race, it is necessary to distinguish between dwarf individuals, which occur occasionally in all series of any extent, and a *race* of small individuals, which are all more or less characterized by their diminutive size. It is only the latter, of course, that is entitled to recognition in any proper varietal sense.

From an inspection of fig. 1, it will appear that, while the small individuals are fairly well scattered over the State and in some cases are no doubt individual dwarfs, they are nevertheless more numerous in the northern part of the State, where the environmental conditions are generally more unfavorable to molluscan life and likely to affect the species as a whole. And it is significant also that of the entire series of 55, no less than 37 occur in the four counties of Charlevoix, Grand Traverse, Huron and Kent. The series from Kent is peculiar in being from so far south and in a county where the typical form is also well represented. The series, however, is well marked and proba-

bly the result of some peculiar local conditions. Unfortunately all data on this point are lacking.

On the whole, therefore, there seems to be reasonable ground for dividing the Michigan series into two groups at this point (24.5 mm.), and for the purposes of this paper they will be treated on that basis, although there is no doubt but that a certain proportion of the series of smaller shells are individual and not racial diminutives. For purposes of convenience and ignoring all questions of synonymy between the varietal names of *maritima*, *minor* and *traversensis*, the smaller race will be termed the "minor" form and the larger race will be referred to as the "major" form.

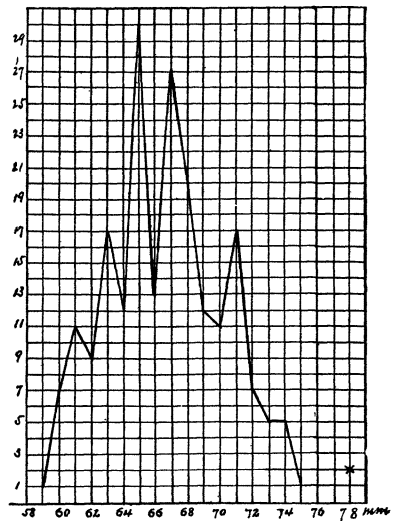


Fig. 6—Axial index—225 Michigan.

The range of variation in the axial index of the Michigan series, taken as a whole, is very considerable, ranging from .59 to .75, with an average of .67. The curve is multimodal, but within rather narrow limits, the major mode being at .65, a conspicuous minor mode at .67, and two others of the same height at .63 and .71. Compared with the Cincinnati series, it shows much greater variability but with nearly the same average proportion. One hundred and seven specimens, or 48 per cent., are between .64 and .68, while only 63, or 28 per cent., are between .66 and .68, as against 59 per cent. in the Cincinnati series.

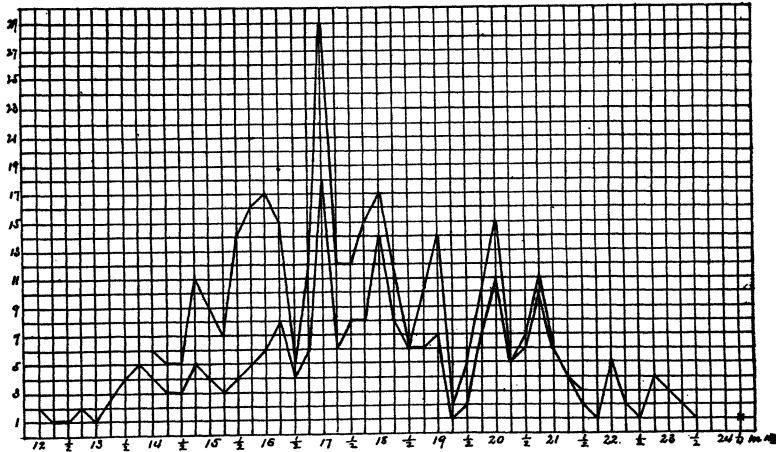


Fig. 7—Heights—Upper line, 225 Michigan and 124 Isle Royale. Lower line, 225 Michigan.

The 170 specimens of the major form vary in height from 15.25 to 24.25, with an average of 19.06 mm.

The major mode is at 17, with well-marked minor modes at 18, 20 and 20.75.

In width (fig. 5) the series vary from 24.75 to 34.25 mm., with an average of 29.31. The major mode is at 29, with conspicuous minor modes at 25, 26.75, 28 and 30.5.

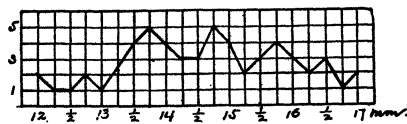


Fig. 8—Heights—55 Michigan, minor form.

The 55 specimens of the minor form vary from 12 to 17 mm. in height, with an average of 14.67. The curve is practically trimodal, with the modes at 13.75, 14.75 and 15.75.

In width (fig. 5) this series ranges from 18.75 to 24.5 mm., with an average of 22.3. The curve is multimodal, with nearly equal modes at 19.75, 20.5, 22, 23, 23.75 and 24, indicating a higher degree of variability than in the major form.

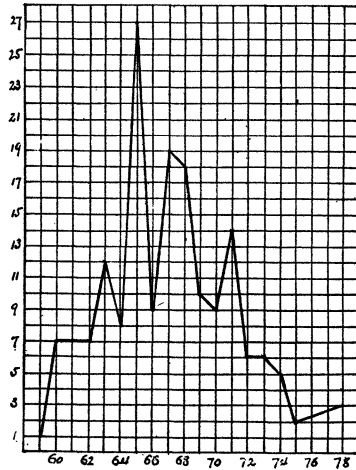


Fig. 9—Axial index—170 Michigan, major form.

The axial index of the major form varies from .59 to .78, with an average of .67.

The curve is multimodal, culminating at .65, with minor modes at .63, .67 and .71.

The similarity between this curve and that for the entire Michigan series is very striking, and both have a general resemblance with that of the Cincinnati series, but show greater variability.

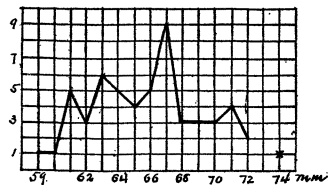


Fig. 10—Axial index—55 Michigan, minor form.

The index of the minor form ranges from .59 to .74, with an average of .66. The curve is also multimodal, but shows greater variability than in the typical series. The major mode is at .67, with minor modes at .61, .63 and .71.

THE ISLE ROYALE SERIES.

This series is of interest as being, like that from Cincinnati, representative of a comparatively restricted region with no great variation

in the environmental conditions. Compared with the general Michigan series, coming from a very much greater extent of territory and representing the effect of very diverse conditions of environment, it would naturally be expected, like the Cincinnati series, to show much less variation. This is true so far as the height of the shell is concerned. But in width the range of variation is much greater and is more similar to that of the general Michigan series. This is owing to the fact that both the Isle Royale and Michigan series extend below 24.5 and include the minor race, which does not appear in the Cincinnati series.

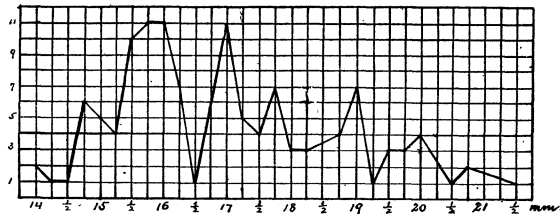


Fig. 11—Heights—124 Isle Royale.

In height the Isle Royale series varies from 14 to 21.5 mm., with an average of 17. As in the Cincinnati series, the curve shows considerable variation, but within narrower limits than in the general Michigan series, the range of variation in both being within $7\frac{1}{2}$ mm., while in the general Michigan series the range of variation covers $12\frac{1}{2}$ mm. The curves of both the Isle Royale and Cincinnati series are very similar, the former, however, showing somewhat great variability and averaging 1.78 mm. lower. Fifty-seven specimens or 46 per cent. are between 15.5 and 17 mm. in height, as against 50 per cent. between 18 and 19 mm. in the Cincinnati series.

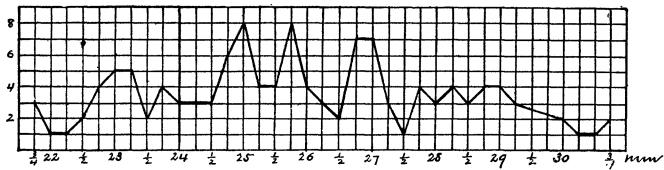


Fig. 12—Widths—124 Isle Royale.

In width the Isle Royale series varies from 21.75 to 30.75 mm., with an average of 25.86. The curve is very similar to that of the general Michigan series, but within somewhat narrower limits, 21.75–30.75

as against 18.75–34.25. The average shell is smaller, being 25.86 as against 26.95 mm.

It is to be noted that a decided break occurs in the curve at 24.5, as in the general Michigan series. Thirty-six specimens or 28 per cent. are 24.5 or less in diameter, as against 24 per cent. in the general series.

Eliminating these, the curve of the remaining 88 specimens of the major form is quite similar in a general way to that of the Cincinnati series and to that of the major race in the general Michigan series, but is like the latter in showing greater variability as compared with the Cincinnati series. The range of variation in the Isle Royale and Cincinnati series is about the same, but only two-thirds that of the general Michigan series. The three series may be compared as follows:

Cincinnati varies from 25.75 to 32.5 or within 6.75 mm.; average 28.35.

Michigan varies from 24.75 to 34.25 or within 9.50 mm.; average 29.31.

Isle Royale varies from 24.75 to 30.75 or within 6.00 mm.; average 26.97.

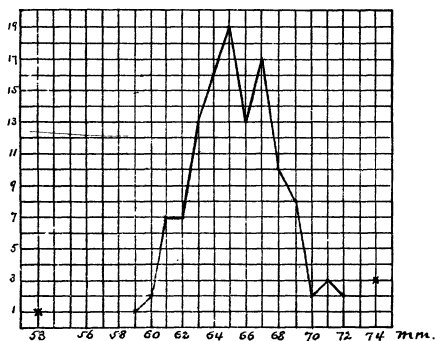


Fig. 13—Axial index—124 Isle Royale.

The axial index of the Isle Royale series varies from .59 to .72, with an average of .65. The curve is bimodal, with the major mode at .65 and the minor at .67. It is intermediate between that of the Cincinnati series and that of the general Michigan series, which it resembles more than it does the former, differing mainly in being more simple by the suppression of the conspicuous minor modes at .61, .63 and .71.

COMPARATIVE NOTES UPON THE DIFFERENT SERIES.

1. The shells of the Upper and Lower Peninsulas.

Of the general Michigan series, 42 are from the Upper Peninsula and 183 are from the Lower. As shown by figs. 5 and 12, the curve of widths in both series is very similar. This being so, if the Upper Peninsular examples from the general series are added to the Isle Royale series, we shall have a fair basis for comparison of the species as between these two portions of the State. There are then 166 Upper Peninsular specimens and 183 from the Lower Peninsula.

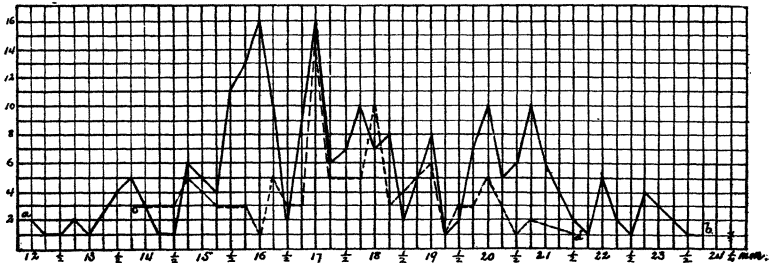


Fig. 14—Heights—*a* to *b*, 183 Lower Peninsula; *c* to *d*, 166 Upper Peninsula.

The Lower Peninsular series varies in height from 12 to 24.25 mm. with an average of 18.10. The Upper Peninsular series ranges from 14 to 21.50 mm., with an average of 17.02.

The Lower Peninsular series not only has a much wider range of variation, but is more variable within that range.

Both series are alike in having a conspicuous mode at 17 mm. But the conspicuous modes at 16 and 21.75 mm. in the Lower Peninsular series are practically lacking in the Upper Peninsular series. In other respects the two curves are very similar.

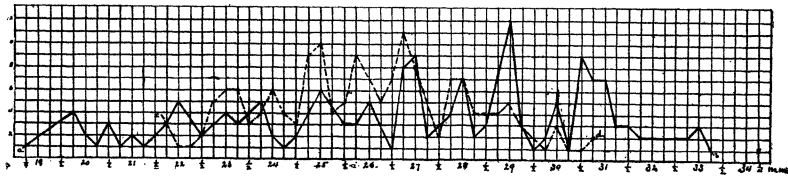


Fig. 15—Widths—*a* to *b*, 183 Lower Peninsula; *c* to *d*, 166 Upper Peninsula.

In width the two series show the same general similarity, exhibiting great variability with conspicuous modes at nearly the same points, the Lower Peninsular series differing mainly in the prominent modes at 29 and 30.5 mm. and in the greater range of variation.

The Upper Peninsular series varies from 21.75 to 30.75 mm. with an average of 25.81, while the Lower Peninsular series ranges from 18.75 to 34.25 mm. with an average of 27.10.

It is to be noted that both curves show the same decided break at 24.5 mm.

Forty-seven or 25.7 per cent. of the Lower Peninsular and 44 or 26.5 per cent. of the Upper Peninsular shells are 24.5 mm. or less in diameter, while 122 or 73.5 per cent. from the Upper Peninsula and 136 or 74.3 per cent. from the Lower belong to the major race so called.

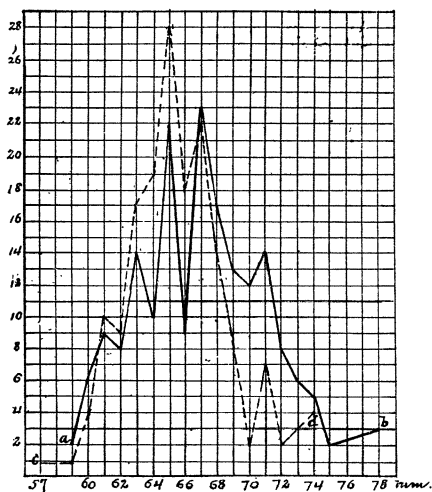


Fig. 16—Axial index—a to b, 183 Lower Peninsular; c to d, 166 Upper Peninsular.

The curves of the axial index of the two series are almost exactly the same, the modes being in every instance at the same point, but with some slight variation in the number of frequencies and with a slightly larger range of variation in the Lower Peninsular series. The average index in the Upper Peninsular series is .654, as against .677 in the Lower Peninsular.

The average shells of the two series compare as follows:

| | Alt. | Diam. | Index. |
|-----------------------|-------|-------|--------|
| Upper Peninsular..... | 17.02 | 25.81 | .654 |
| Lower Peninsular..... | 18.10 | 27.10 | .677 |

The average Upper Peninsular shell is 25.81 x 17.02 mm. If it were of the same proportions as the average Lower Peninsular shell, it should be 17.24 mm. in height and of course with the same index.

That is, the average Upper Peninsular shell is smaller by 1.08 mm. in height and 1.29 mm. in width and proportionately more depressed by .22 mm.

2. The Minor Races.

The several series of the "minor" form may be tabulated as follows, using the average shell as a basis of comparison:

| | Alt. | Diam. | Index. |
|---|-------|-------|--------|
| 1. <i>maritima</i> | 15.60 | 22.70 | .68 |
| 2. <i>minor</i> Sterki..... | 14.25 | 21.25 | .67 |
| 3. <i>traversensis</i> | 13.31 | 21.31 | .63 |
| 4. Upper Peninsular series..... | 15.44 | 23.31 | .66 |
| 5. Lower Peninsular series..... | 14.04 | 22.18 | .66 |
| 6. General Michigan series..... | 14.67 | 22.30 | .66 |
| 7. Total Michigan series (4 and 5)..... | 14.74 | 22.75 | .66 |

From this table it will be seen—

1. That all the Michigan shells of the minor form are more depressed than the typical *maritima* and *minor* Sterki. This is specially true of the typical *traversensis*.

2. That, with the exception of the typical *traversensis* series, all the Michigan series have the same index. It is to be noted, however, that the *traversensis* series is included in series 5, 6 and 7, and that, if that series was eliminated, the index of these series would be somewhat increased and more closely approximated to that of *maritima* and *minor* Sterki.

3. That the Upper Peninsular series average larger than that of the Lower Peninsula by 1.4 mm. in height and 1.13 mm. in width. This is in marked contrast with the major forms of the two series, in which the Lower Peninsular shell is larger by 1.08 mm. in height and 1.29 mm. in width. This is well shown by comparing the two curves in fig. 15.

4. On the whole, however, the several series show a remarkable uniformity. It would seem to be reasonably clear that the minor form of *albolabris* varies in about the same way within certain fairly defined limits. There is reason to believe that in certain locations these peculiarities affect the whole race, and in such cases is worthy of varietal recognition. It is equally true, no doubt, that many of the minor shells are merely depauperate individuals. But whichever is the case, so far as size and proportion are concerned, the amount and range of variation is substantially the same. The explanation of this probably is that the amount of depauperization that the species will sustain and still exist is substantially the same everywhere,

and that consequently the result of unfavorable conditions, whether applied to the individual or to a local colony, will be within certain limits very similar.

It is to be noticed that the axial index of the major and minor forms is substantially the same. That is to say, that while there is a well marked division into two races, the variation is mainly one of size and not of proportion.

3. The Major Races.

The average of the several "major" series may be compared as follows:

| | Alt. | Diam. | Index. |
|--|-------|-------|--------|
| 1. Cincinnati series..... | 18.78 | 28.35 | .66 |
| 2. Upper Peninsular series..... | 17.59 | 26.79 | .65 |
| 3. Lower Peninsular series | 19.44 | 29.26 | .677 |
| 4. General Michigan series..... | 19.06 | 29.31 | .67 |
| 5. Total Michigan series (2 and 3) | 18.52 | 28.03 | .665 |

Taking the average Cincinnati shell as a basis for comparison, we find that the Upper Peninsular shell is smaller both in height and width and also more depressed; while the Lower Peninsular shell is both higher and wider and proportionately more elevated. This is also true of both series 4 and 5, the latter, however, being very close to the Cincinnati type in every particular.

As it is a matter of common knowledge that the southern *albolabris* are usually larger than those from the Northern States, the larger size of the average Lower Peninsular shell seems peculiar. But this is probably owing to the fact that the series is not an "unprejudiced" one, but, as already explained, contains a larger proportion of selected specimens than would occur in a natural series.

The inclusion of a certain proportion of Upper Peninsular shells in the general Michigan series serves to reduce the average size, and in series 5 a still greater addition of the smaller northern form brings the average down nearly to that of Cincinnati. It seems probable, therefore, that a large and unprejudiced series of southern Michigan shells would show an average not to exceed and quite likely somewhat smaller than the Cincinnati type.

While it is true that the results obtained from the Lower Peninsular series are perhaps subject to criticism as to size, there does not seem any ground to question the results obtained by a comparison of the axial indices, which show that the Upper Peninsular shell is somewhat more depressed, while the Lower Peninsular type is considerably more elevated than the Cincinnati shell.

In this connection it is to be noted that the axial index shows simply the proportion between the height and the width. It does not necessarily show that one race is more conical than the other. It is to be regretted that no satisfactory method for definitely determining this fact was found. In the absence of specific proof, it is only possible to record the writer's impression, derived from a careful study of the material, that as a rule the Lower Michigan shells are not only proportionately more elevated, but are actually more conical in shape.

CONCLUSIONS.

From a careful study of the foregoing data, the following conclusions seem to be justified:

1. That *Polygyra albolabris* in Michigan exhibits great variability in size.
2. That both the Upper and Lower Peninsular series show a well-marked division into two parts, the dividing line being at 24.5 mm. in width.
3. That this dividing line corresponds quite exactly with that separating the several described minor varieties and the typical form as exemplified by the Cincinnati series.
4. That the evidence tends to show that when depauperization takes place in *P. albolabris*, whether in individuals or in local races, the results are within certain fairly definite lines.
5. That when depauperization affects substantially the whole race in a particular locality or district, it is sufficiently permanent to be worthy of varietal recognition.
6. That the depauperate shells of the Lower Peninsula are on an average smaller and more depressed than those of the Upper Peninsula.
7. That the major (or typical) series of the Upper Peninsula is smaller and more depressed than that from the Lower Peninsula.
8. That the major series of the Lower Peninsula is larger and more elevated than the Cincinnati series.
9. That this is probably to be accounted for by the fact that the Michigan series is not an unprejudiced one and contains a large proportion of selected specimens.
10. That the average shell of both Michigan series combined is substantially the same as that of the Cincinnati series.
11. That the great variability of the Michigan series, taken as a whole, as compared with the Cincinnati series, is due mainly to the greater diversity of environmental conditions.